

# The Treatment of Acute Infections of the Hand

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## SUMMARY

*Acute infections of the hand are serious and frequently arise from a trivial wound which has been neglected or improperly treated. Accurate diagnosis, prompt institution of treatment, and early restoration of function are essential for successful treatment. Results in the treatment of acute infections of the hand are greatly improved by the rigid practice of a method of operation which recognizes fundamental surgical principles.*

ACUTE infections of the hand are always serious. They all too frequently arise from a neglected or improperly treated trivial lesion, such as a scratch, a tiny puncture wound, or an infected callosus. Secondary infection must be constantly guarded against. Infections due to organisms which are acclimated to growth in human tissues are rapidly invasive and extremely destructive. The crippling and disability which frequently result may be extreme and may seriously affect the earning capacity of the individual.

## GENERAL CONSIDERATIONS

When a surgeon assumes the responsibility for treating an acute infection of the hand, he must first determine whether the infection is localized or is a spreading infection such as a cellulitis or lymphangitis. In the spreading infections, operation is contraindicated and treatment must be confined to conservative measures. In the localized infection, immediate drainage is indicated. Prior to operation the exact anatomical location of the infection must be determined. On the basis of anatomical pathways, the possible routes of spread must be visualized and anticipated. It should be stressed that delay in the prompt institution of treatment, either conservative or radical, may jeopardize the patient's hand and, indeed, his life.

## FUNDAMENTAL SURGICAL PRINCIPLES

The results in the treatment of acute infections of the hand have been greatly improved by the practice of a method of operative procedure which rigidly observes certain fundamental surgical principles. These principles have been clearly stated by Koch,<sup>8-15</sup> Mason,<sup>18-26</sup> and Allen,<sup>1</sup> and are as follows:

### *Preparation of the Field of Operation*

The preparation of the field of operation should not cause pain or add injury. It is the authors' routine to prepare the skin by gentle cleansing with

bland white soap, sterile water and cotton for a ten-minute period. Following this cleansing, the area is lavaged with sterile saline solution. Coarse brushes, soap tinctures and chemical antiseptics are not used as they frequently have an irritating and oftentimes a destructive effect upon inflamed and injured tissues.

### *Anesthesia*

General anesthesia is used routinely except in the case of small superficial subcuticular abscesses which can be drained without anesthesia. Most incisions on the hand require careful step-by-step technique and this can be best accomplished with the patient in general anesthesia. Ethylchloride spray as an anesthetic agent should be discarded. It freezes the tissue and lowers the local resistance to infection. The freezing of the tissue and the momentary anesthesia do not allow for adequate, careful incision or identification of important structures. Local injection of an anesthetic agent also causes trauma, and injection into inflamed tissues may easily carry infection into uninvolved areas. For general anesthesia, the author usually uses sodium pentothal intravenously, supplemented by light inhalation anesthesia.

### *Hemostasis*

A bloodless field is indispensable in operations upon the hand. With complete hemostasis, accurate incision and adequate drainage of the abscess can be performed, and at the same time important structures may be clearly visualized, readily identified, and protected from injury. A bloodless field is obtained by applying a pneumatic blood pressure cuff to the upper arm without constriction. The entire cuff is then smoothly wrapped in place with 3-inch wide gauze bandage to prevent escape of any part of the rubber bag from beneath the bandage as the cuff is inflated. Just before operation is begun the arm is elevated for at least one minute, following which the blood pressure apparatus is rapidly inflated to a pressure of 260 mm. of mercury. In children as well as adults, cuff pressure is maintained continuously until incision and drainage of the abscess is completed. The cuff is then deflated and complete hemostasis obtained. The author has encountered no instance of nerve injury when the cuff was used in this manner.

### *Incisions*

The first requirement for an incision of the infected hand is that it be large enough to provide ample drainage. At the same time, it should be such that it will not lead to further disability or 'induce spread of infection to adjacent spaces.

As a general rule, incisions should lie parallel to skin creases where skin tension is at a minimum.

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Incisions at right angles to skin creases should be avoided as they heal with a thickened contracting scar. An abscess process in a finger is best drained through a midlateral incision, using the ends of the transverse finger creases as guides. Particularly to be avoided are the midline incisions of the fingers and wrist. They lead to scar contracture deformities; and, in the finger, if the tendon sheath is also incised, they may permit prolapse of the flexor tendon. Incision on two sides of a finger or hand are also to be avoided as they may lead to slough and are not necessary for ample drainage.

#### *Instruments*

Operations upon the hand are best performed with the aid of a few carefully selected plastic instruments which are particularly adapted to the atraumatic technique required. The number 15 Bard-Parker blade is indispensable. Plastic forceps are most useful in the handling of the delicate anatomical structures of the hand. The largest clamp used for hemostasis is the small mosquito clamp and the small curved-end Providence clamp. Small plastic hook retractors and Senn retractors are very useful. Number 100 cotton is used as ligature material. A large "asepto" syringe filled with saline is used to moisten the exposed tissues at frequent intervals and to irrigate the abscess cavity following incision and drainage.

#### *Drains*

The purpose of drains is to prevent agglutination of the wound edges and to aid the escape of infectious exudate.

Following adequate incision and drainage of the abscess, the wound edges are kept apart by lightly inserting fine mesh vaseline gauze at one or both angles of the wound. Firm packing of the wound is avoided as it acts as an impediment to free drainage.

Drains are routinely removed in 24 to 48 hours and should not be replaced. The reinsertion of drains adds infection and delays the healing process. If the incision is not of adequate length or is not properly placed the reinsertion of drains will not compensate for these surgical errors.

The through-and-through drain has no place in operations upon the hand. Its use causes hemorrhage and spreads infection throughout the hand. It is one of the important causes of osteomyelitis of the metacarpals. In the finger, the through-and-through drain may cause injury to the neurovascular bundles and may lead to necrosis of the flexor tendon sheaths and tendons.

Persistent drainage from the wound often indicates the presence of a foreign body or devitalized tissue such as nail, tendon, or bone. Drainage will continue until these are removed. A drain itself is a foreign body and delay in its removal is often the cause of persistent drainage.

#### *After-Care*

In the after-care of the infected hand the aim is to provide moist heat, rest and elevation.

Immediately following incision and drainage of

the abscess, a voluminous fluffed gauze dressing is applied. This dressing is devised to provide continuous moist heat, immobilization and rest under aseptic conditions. In applying this dressing, sterile gauze is placed between all fingers to keep them separated and to prevent maceration. The hand and arm are then covered with fluffed gauze and put at rest in a functional position on a sterile aluminum splint. The entire dressing, including the splint, is then incorporated in a folded sterile towel. This towel is folded so as to leave several small apertures through which fluid can be added to the dressing. To provide continuous moist heat, an electric baker is placed over the dressing and 10 to 20 drops of sterile saline solution are inserted into the gauze dressing every two hours. At no time should the towel be allowed to become wet. The wound is dressed at 24-hour intervals with strict aseptic precautions. To prevent secondary infection from the nose and mouth a surgical mask is worn by the surgeon during the care of all open wounds.

Usually after two to four days the acute process has subsided and these dressings can be supplanted by warm sterile soap-and-water soaks once or twice daily for 20 minutes. To prevent maceration, the hand is covered with a sterile towel after each soak and allowed to dry under the electric baker.

Sterilization of the wound can be hastened by periodic debridement of crusts and necrotic tissue and, if necessary, by periodic irrigation of the wound with sterile saline or Dakin's solution. Antiseptic solutions and antiseptic ointments are not used during the after-care of the wound, as they cause irritation and interfere with cleanly post-operative care. Hot compresses are not applied to an open wound, as they may frequently be a source of secondary infection.

The importance of elevation as an aid in the healing of inflamed and injured tissues is well known. Elevation of the extremity improves circulation and lessens the edema and congestion which frequently attend infections of the hand. Upon the patient's return to the ward, the author routinely elevates the infected part above the heart level by means of two pillows which are placed on an adjustable bedside stand.

#### *Preservation and Restoration of Function*

The position of the hand during the treatment of the acute phase is of the greatest importance. It should be immobilized in what has been termed "the position of function."<sup>7</sup> In this position, the hand would appear to be grasping an object the size of a large orange. The forearm is placed in a position midway between pronation and supination. The wrist is dorsiflexed about 45 degrees. The fingers are slightly separated, and the joints of the fingers flexed about 30 degrees. The thumb is abducted from the hand and rotated so that its flexor surface faces the volar surface of the fingers. If ankylosis or limited motion is to occur in the joints of the fingers or hand, fixation in this functional position

would be preferable to the flat or claw hand which might otherwise result.

Splinting<sup>9</sup> plays an essential part in the treatment of all infections of the hand, and its importance cannot be overemphasized. Properly fashioned splints are indispensable in helping to maintain the hand in the position of function. Splints also provide immobilization and rest which are so necessary for the proper healing of inflamed tissues. Splints are readily fashioned from thin aluminum sheets with a pair of tin snips to meet the requirements of the individual case. The aluminum "universal hand splint" recently devised by Allen and Mason<sup>1</sup> is well adapted to the treatment of the more serious hand infections and deserves special mention. This splint is called the "universal hand splint" because it may be used for either the right or left hand and for a wide variety of conditions. It is excellent for maintaining the hand at rest in a position of function and is particularly adapted to the application of voluminous fluffed gauze and pressure dressings.

As soon as the acute infectious process has subsided, purposeful active motion must be started. This is best performed while the hand is in the sterile hand soak. Active motion started early will not only help to restore function but, by preventing joint stiffness, may save the patient many weeks of physiotherapy.

If residual stiffness persists, active and passive exercises, preferably in a warm soap-and-water soak, supplemented by massage, are beneficial. In those cases which have been neglected or in which pronounced fibrosis and stiffness persist, physiotherapy and tension splinting may be required. It should be stressed that forceful manipulation of the stiffened and fibrosed hand with the patient anesthetized is harmful and is to be condemned. In some cases, specialized operative procedures, such as skin grafting, amputations, nerve and tendon operations, capsulotomy and arthroplasties, may prove beneficial.

#### INCISIONS FOR SPECIFIC TYPES OF INFECTIONS

Many types of incisions<sup>2,3,4,7,13,16,17,20,27,28,29</sup> have been advocated for drainage of localized infections of the hand. There are certain incisions which the author has found to be practical and effective in the treatment of the more commonly encountered infections. These incisions conform to fundamental surgical principles and will be discussed as they apply to the following hand infections:

##### *Felon*

A felon is an acute surgical emergency and immediate incision to prevent osteomyelitis is mandatory. A felon is adequately drained by a mid-lateral hockey-stick incision along one side of the distal phalanx (see Figure 1). The scalpel is swept across the distal phalanx parallel to the surface of the bone and about halfway between it and the skin. The space is widely opened by transecting all vertical septa. Care must be taken in dissecting to avoid injuring the neurovascular bundles and to avoid open-



Figure 1.—Incision for felon.

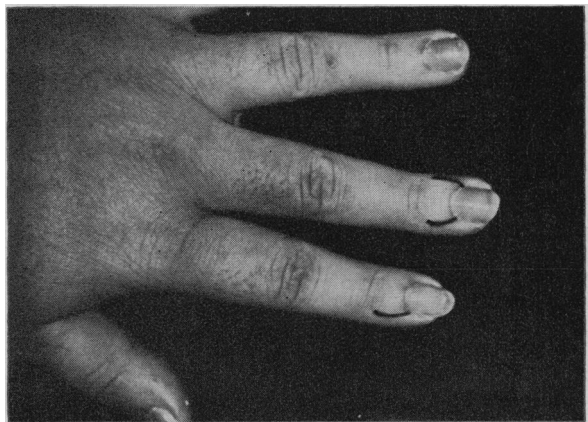


Figure 2.—Incision for paronychia.

ing the sheath of the flexor tendon which inserts at the base of the distal phalanx. The bilateral incision in the treatment of felon is not necessary for adequate drainage and often leads to slough. The fish-mouth incision should be avoided, as it frequently results in a painful deformity of the fingertip.

##### *Osteomyelitis*

Osteomyelitis is a frequent complication of the infected hand and commonly occurs in felon. Koch<sup>11</sup> pointed out that osteomyelitis is best treated by providing adequate incision and drainage of the overlying soft tissues. Should necrotic bone separate, it will be extruded, or can be lifted gently out of the wound. Radical operation upon the bone with curette and chisel results in an unnecessary sacrifice of bone and an extension of the osteomyelitic process into uninvolved bone.

##### *Paronychia*

If observed early, before definite abscess formation occurs, paronychia can usually be aborted by hot soap-and-water soaks, a protective dressing, penicillin given parenterally, and deep x-ray therapy. Splinting of the finger is essential. If abscess formation is superficial, as it is in most cases, it can be drained by merely pushing the eponychium laterally from the nail until an adequate opening in

the abscess cavity is obtained. In severe cases in which the abscess process has separated the nail from the nail bed, adequate drainage of the subungual abscess may be obtained by complete removal of the proximal one-third of the nail. Unilateral or bilateral parallel incisions one-half inch long extending from the base of the nail may be required (see Figure 2). The flap thus formed is elevated and the nail removed, with care taken to remove all nail fragments. A layer of vaseline gauze is laid under the flap for 24 hours and the finger dressed and splinted.

Persistence of a chronic granulating mass following acute paronychia is usually due to a retained segment of devitalized nail which must be removed for cure. Cauterization of this granulating mass causes necrosis of tissue and accomplishes nothing in helping to remove the devitalized segment of nail. If the infection is intractable, trichophytosis, monilia or syphilis should be suspected.

#### *Subungual Abscess*

In this condition, pus is localized beneath the nail and frequently is situated under the distal portion. Such an abscess is drained by excising a "V" wedge of nail over the site of the abscess (see Figure 3). This can usually be performed without anesthesia.

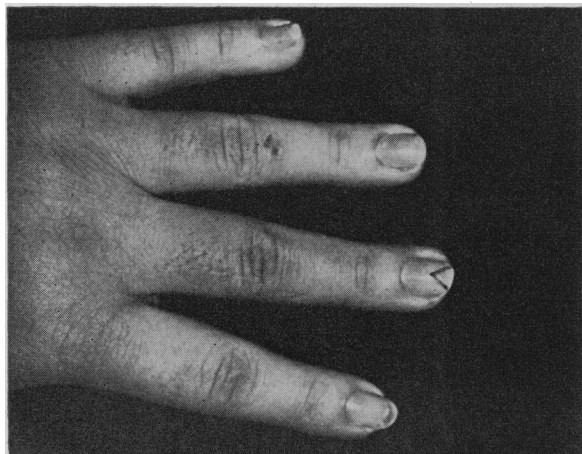


Figure 3.—Subungual abscess.

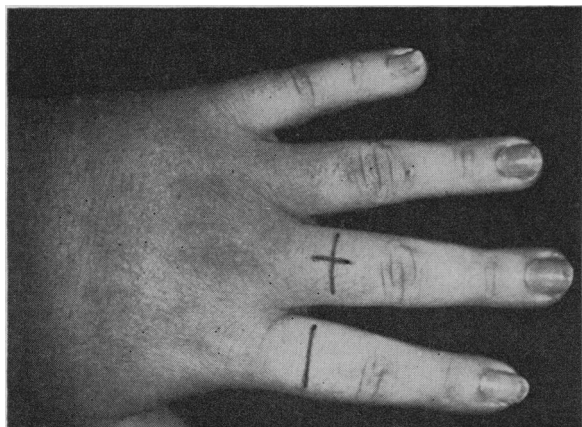


Figure 4.—Incision for furuncle and carbuncle.

#### *Furuncle and Carbuncle*

A small hair follicle infection, if observed early and not traumatized, will usually subside with conservative treatment. Here again, splinting is essential. The small furuncle can usually be adequately drained by a single transverse incision (see Figure 4). Carbuncles and larger furuncles may be drained by cruciate incisions. In the case of the carbuncle, the incision should extend beyond the apparent border of the infectious process. The flaps are then debrided of all necrotic tissue. The abscess cavity is irrigated and packed open.

#### *Subepithelial Abscess*

A subepithelial abscess is a superficial accumulation of pus between the epidermis and dermis. If uncomplicated by deep extension, the abscess can be drained by trimming away the overlying epidermis, usually without anesthesia. At times such an abscess may perforate the dermis and extend into the subcutaneous tissues. The dermis should always be carefully examined for any opening suggesting deep extension of the abscess into the subcutaneous tissue. For drainage of the deeper abscess, adequate incision of the dermis is required.

#### *Subcutaneous and Subfascial Infections of the Finger*

Subcutaneous and subfascial infections of the finger can be adequately drained by a midlateral incision on one side of the finger (see Figure 5). This incision should be extended for the full length of the abscess process. Care must be taken not to injure the neurovascular bundle and to avoid opening an uninvolved tendon sheath. Bilateral incisions are not necessary for adequate drainage.

#### *Collar-Button Abscess and Web Space Abscess*

In collar-button abscess a subcutaneous abscess of the palm extends under the deep palmar fascia into the deeper tissues and web spaces. The abscess may point dorsally in the webs and dorsal subcutaneous space and may involve lumbrical spaces. A transverse incision in the palm parallel to the distal palmar crease provides excellent drainage for this type



Figure 5.—Incision for subcutaneous and subfascial infections.

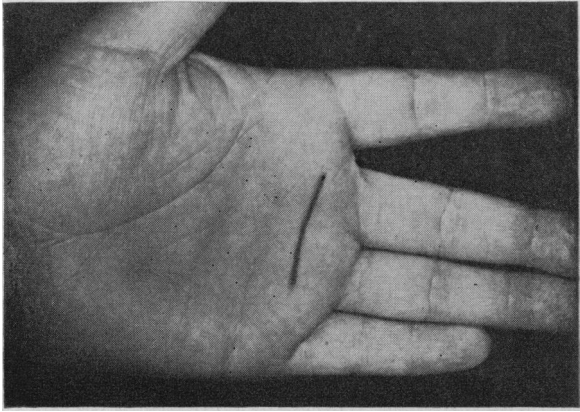


Figure 6.—Incision for collar button and web space abscess.

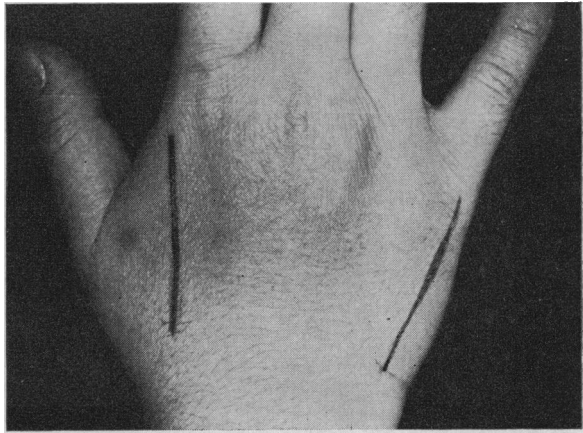


Figure 8.—Optional incisions for subaponeurotic abscess.

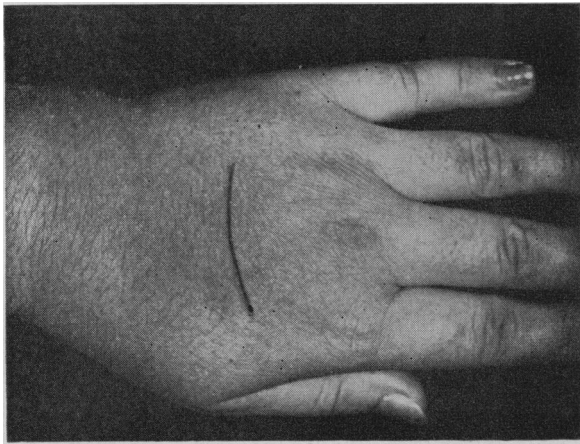


Figure 7.—Incision for dorsal subcutaneous abscess.

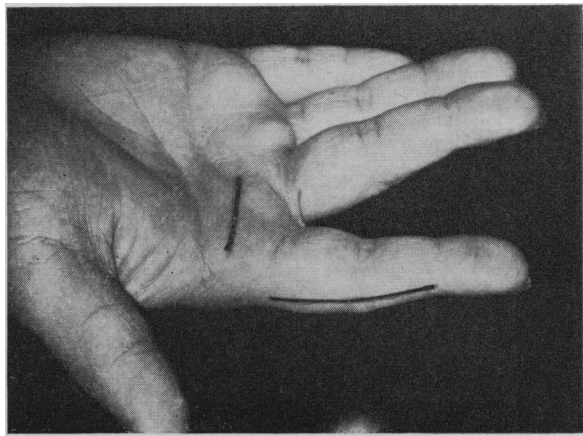


Figure 9.—Incision for tenosynovitis.

of subcutaneous abscess and its deep extension (see Figure 6). Rarely is it necessary to drain the deeper abscess process by supplemental dorsal incisions. Vertical incisions which divide the webs are to be avoided, as they heal slowly and leave web deformities and contractures.

#### *Dorsal Subcutaneous Abscess and Dorsal Subaponeurotic Space Abscess*

A dorsal subcutaneous abscess can be satisfactorily drained by a transverse incision directly over the abscess and parallel to the dorsal hand skin creases (see Figure 7).

The dorsal subaponeurotic space abscess which lies deep to the extensor tendons can be adequately drained by a radial or ulnar lateral incision on the dorsum of the hand or by a long transverse incision on the dorsum of the hand (see Figure 8).

#### *Tenosynovitis*

Acute tenosynovitis of the suppurative and non-specific type is a surgical emergency and demands immediate drainage. Operation is contraindicated only in those cases which are complicated by a rapidly spreading infection.

Drainage of the infected tendon sheath in a finger can be obtained by a midlateral incision extending

from the distal interphalangeal joint crease to the base of the finger (see Figure 9). The neurovascular bundle must be identified and retracted dorsally. After the tendon sheath has been exposed, it is fully incised along its lateral aspect. When the sheath is incised well laterally, the tendon does not prolapse forward, and it is not necessary to preserve segments of the sheath as annular ligaments.

Rarely is tenosynovitis confined to the digital sheath or a part of the digital sheath. In most cases the proximal cul-de-sacs of the flexor tendon sheaths of the index, middle, and ring fingers are also involved and these can be drained by a 1-inch transverse incision in the palm distal to and parallel to the distal palmar crease (see Figure 9).

#### *Ulnar Bursa Infection*

Drainage of the flexor tendon sheath of the little finger and the ulnar bursa requires three separate incisions (see Figure 10). The flexor tendon sheath in the little finger is drained by an ulnar midlateral incision. The ulnar bursa in the palm is drained by an incision which begins at the distal palmar crease and follows the radial border of the hypothenar muscles to the base of the hand. The proximal extension of the ulnar bursa is drained by a three-inch incision on the ulnar aspect of the forearm and wrist.



This incision is placed in the groove between the flexor carpi ulnaris tendon and the ulna. The ulnar nerve and vessels are retracted forward with the tendons, and dissection is carried into the retroflexor space along the pronator quadratus muscle. The distended ulnar bursa can then be visualized and drained.

In draining the ulnar bursa it is usually not necessary to transect the transverse carpal ligament. However, if decompression must be provided, the transverse carpal ligament can be transected well laterally without ill effects.

It should be emphasized that when both the radial and ulnar bursae are involved, as usually occurs, both can be adequately drained through the ulnar forearm incision.

#### *Radial Bursa Infection*

The flexor tendon sheath of the thumb and the radial bursa are drained by two incisions. The first, a midlateral incision, is placed along the ulnar side of the thumb and is extended proximally over the thenar eminence to within one inch of the transverse carpal ligament (see Figure 11). Here it is discontinued to avoid injury to the motor branches of the median nerve which innervate the thenar muscles. The radial bursa in the wrist can be drained by a three-inch incision on the radial side of

the wrist and distal forearm (see Figure 11). This incision is made just anterior to the radius and is comparable to that used for drainage of the ulnar bursa.

The radial and ulnar bursae are potentially or actually communicating in practically all cases. When one of these spaces becomes infected, the other is soon involved. At times one space is involved and the other space is only questionably so. In such cases, it is preferable to explore the questionably involved space first. If the bursa is not involved, little harm will be done. However, if an uninvolved space is explored after an infected space is drained, it could hardly escape infection.

#### *Midpalmar Space Abscess*

A transverse incision in the palm along or parallel to the distal palmar crease gives ready access to the midpalmar space<sup>6</sup> and to the associated lumbrical canals (see Figure 12). This incision should not be developed more radial than the middle finger metacarpal bone if opening the thenar space is to be avoided.<sup>6</sup> The use of general anesthesia and complete hemostasis are indispensable in draining this space, as the incision in the skin and deep palmar fascia lies at right angles to the course of the underlying nerves, vessels, and tendons.

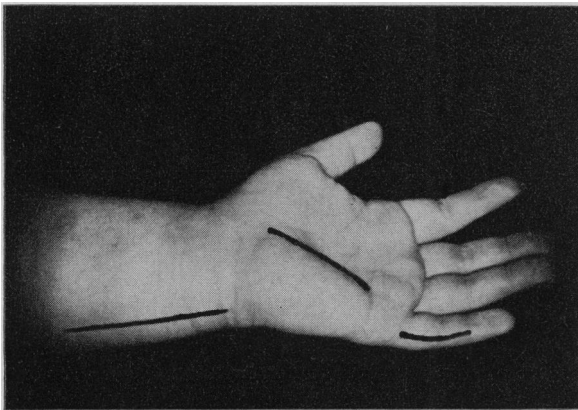


Figure 10.—Incisions for ulnar bursa.

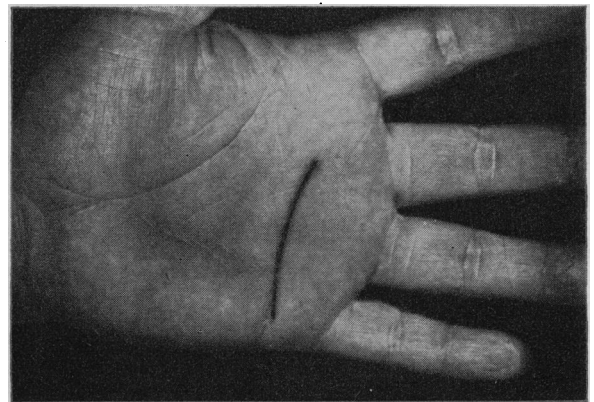


Figure 12.—Incision for midpalmar space abscess.

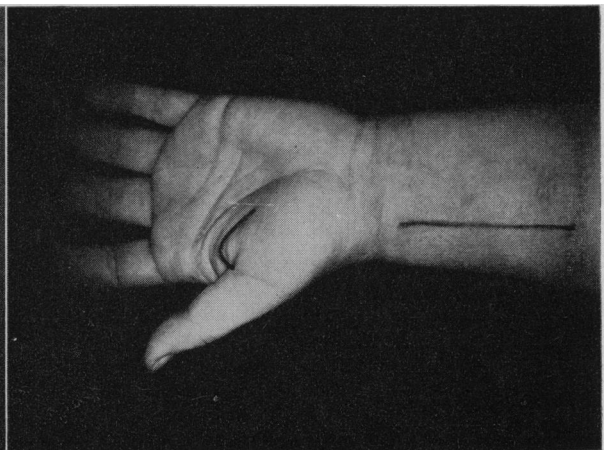
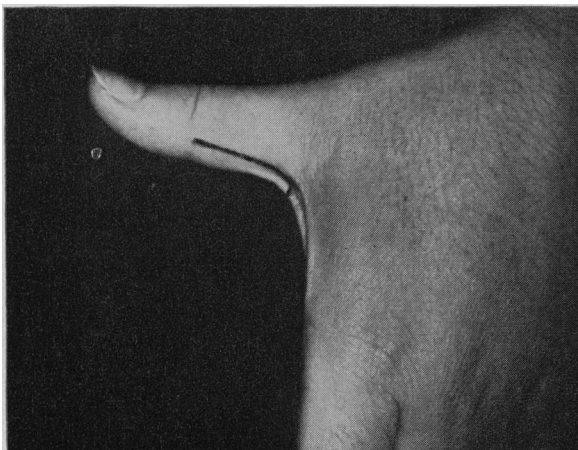


Figure 11.—Incisions for radial bursa infections.



Figure 13.—Incision for thenar space abscess.

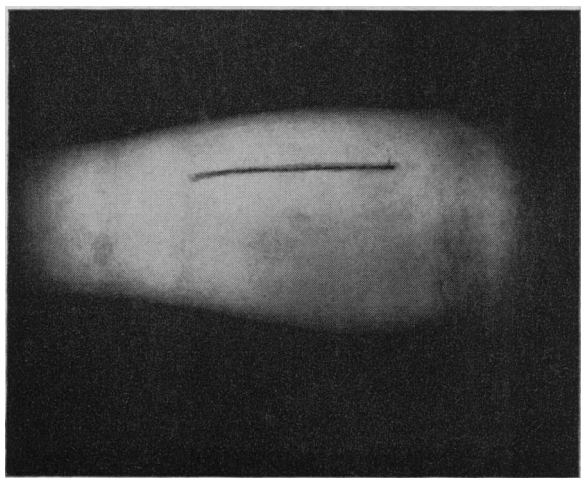


Figure 14.—Incision for proximal forearm abscess.

#### *Thenar Space Abscess*

The thenar space<sup>6</sup> is approached from the dorsum of the hand. This space is adequately drained through a 1½-inch incision developed along the radial border of the first dorsal interosseous muscle (see Figure 13). The incision almost parallels the dorsal margin of the web between the thumb and forefinger and is carried through the skin and subcutaneous tissue. Dissection is then developed along the palmar surface of the adductor pollicis muscle into the thenar space. After evacuation of the abscess, drainage is assisted by the insertion of a fine-mesh vaseline gauze pack to keep the wound edges apart.

#### *Deep Abscess of the Forearm*

Abscess of the retroflexor space usually arises as a result of rupture of an infected radial or ulnar bursa. An abscess of the retroflexor space may be drained through a three-inch incision on the ulnar forearm identical to that used in draining the ulnar bursa (see Figure 10).

Infection from the retroflexor space may extend up the arm along the course of the median and ulnar nerves and the ulnar artery into a more superficial position between the flexor digitorum sub-

limis and profundus muscles. Deep abscess of the proximal forearm is drained by a longitudinal incision on the ulnar aspect of the forearm. This incision, at least three inches in length, is placed over the junction of the upper and middle thirds of the forearm and is developed between the flexor carpi ulnaris and flexor digitorum sublimis muscles (see Figure 14). This approach allows ready access to the abscess cavity and provides for ample drainage.

#### GENERAL MEASURES AND SPECIFIC TREATMENT

##### *General Measures*

Ordinarily, a patient with acute infection of the hand is sick. In cases in which there are general symptoms due to sepsis, or in which these symptoms are anticipated, general care of the patient should be instituted promptly. During the acute stage of the infection, the patient should be put to bed and kept warm in surroundings which are quiet and restful. The diet should be of the high caloric type and may be supplemented by vitamins, proteins, and iron as indicated. The fluid intake should be sufficient to produce 1,000 to 1,500 cc. of urine output daily. Sedatives and analgesics are used for relief of restlessness and pain, but in amounts which will not mask symptoms due to extension of the infection. Hyperpyrexia is combated by alcohol rubs and tepid sponge baths.

##### *Specific Measures*

The antibiotics<sup>25, 26</sup> are frequently used in the treatment of acute infections of the hand and are particularly effective in the control of rapidly spreading infections. Penicillin<sup>2, 5, 16, 17, 24</sup> remains the antibiotic of choice except in those cases in which bacteriological analysis reveals the presence of organisms which are resistant or antagonistic to penicillin. The remaining antibiotics and chemotherapeutic agents, although used less frequently, have their specific indications and are usually used as an alternative to or in combination with penicillin. The antibiotics are generally administered parenterally but at times are used topically with very gratifying results. The sulfonamides are not recommended for local use because of their tendency to cause irritation and adhesions and because of their tendency to aggregate and behave as foreign bodies.

Zinc peroxide, if used exactly as described by Meleney (cited by Requarth<sup>28</sup>), is of value in the treatment of microaerophilic hemolytic streptococcal infections as well as in other types of anaerobic infections such as human bite infection and gas gangrene. However, since the advent of the antibiotics, the author has found fewer indications for the use of zinc peroxide.

The author's use of vaccines and sera<sup>3</sup> in the treatment of acute nonspecific infections of the hand is limited to tetanus antitoxin and polyvalent antigas bacillus serum.

Whole blood transfusions,<sup>4, 29</sup> preferably given in 250 cc. amounts every second or third day, are invaluable in the treatment of a patient critically ill

with an acute infection of the hand. Immunotransfusions have limited applicability, but are of value in selected cases.

Deep x-ray therapy has also proved to be of benefit in certain cases of acute infections of the hand. It is particularly helpful in aborting and localizing infections such as paronychia, furuncle, and carbuncle. It is worthy of trial in the treatment of uncontrolled gas bacillus infections and has proved to be effective in the treatment of osteomyelitis of the bones of the hand.

The author has had no experience with the injection of penicillin solution locally into abscesses and inflamed tissues. This method is reportedly painful and opens up new avenues to the spread of infection. Injecting into inflamed tissues does not conform to fundamental surgical principles and is not recommended.

Glowing reports<sup>2, 5, 16, 17</sup> have recently appeared, originating particularly in England, advocating a new method of treatment of localized abscesses of the hand. This treatment consists of excision and immediate primary closure combined with immobilization and penicillin therapy, both local and parenteral. The supporters of this method contend that treatment in this manner not only shortens the period of treatment and disability, but lessens the need for hospitalization and minimizes the extent of disability.

It should be stressed that sufficient time has not yet elapsed, and the number of patients treated by excision and primary closure, immobilization, and penicillin is relatively small. This method is still on trial and final conclusions concerning its efficacy cannot yet be drawn.

#### REFERENCES

1. Allen, H. S., and Mason, M. L.: A universal splint for immobilization of the hand in the position of function, *Qu. Bull. N. Western Univ. Med. Sch.*, 21:218-227, Fall 1947.
2. Barclay, G. A.: Infected hands treated with systemic penicillin, *Brit. Med. Jour.*, 1:175-179, Jan. 29, 1949.
3. Bunnell, S.: *Surgery of the Hand*, J. B. Lippincott Co., Philadelphia, 1944.
4. Cutler, C. W.: *The Hand, Its Disabilities and Diseases*, W. B. Saunders Co., Philadelphia, 1942.
5. Florey, M. E., and Williams, R. E. O.: Treatment of hand infections with penicillin, *Lancet*, 1:23-81, June 15, 1944.
6. Flynn, J. E.: Surgical significance of the middle palmar septum of the hand, *Surgery*, 14:134-141, July 1943.
7. Kanavel, A. B., and Mason, M. L.: Infections of the hand, Reprint from *The Cyclopedia of Medicine, Surgery and Specialties*, 1939.
8. Koch, S. L.: Acute infections of the hand, *South. Med. Jour.*, 37:157-159, March 1944.
9. Koch, S. L.: Injured tissues need rest, editorial, *Surg. Gyn. Obst.*, 82:749-751, June 1946.
10. Koch, S. L.: The care of infected wounds, *Inter. Abs. Surg.*, 105-113, Feb. 1, 1938.
11. Koch, S. L.: Osteomyelitis of the bones of the hand, *Surg. Gyn. Obst.*, 64:1-8, Jan. 1937.
12. Koch, S. L.: The prevention and control of surgical infections in a general hospital, Reprint from the *Jour. Kans. Med. Soc.*, Jan. 1942.
13. Koch, S. L.: Prevention and treatment of infections of the hand, *J.A.M.A.*, 116:1365-1367, Mar. 29, 1941.
14. Koch, S. L.: Some surgical principles in the treatment of injuries and infections of the hand, Reprint from the *Jour. of the Kans. Med. Soc.*, March 1939.
15. Koch, S. L.: The treatment of open wounds, Reprint from the *Bull. Amer. Col. Surg.*, June 1940.
16. Loudon, J. B., Miniere, J. D., Scott, J. C.: Infections of the hand, *Jour. Bone and Joint Surg.*, 30B:409-429, Aug. 1948.
17. Marsden, J. A.: Penicillin therapy for tendon sheath infections, *Med. Jour. Australia*, 1:435-436, Mar. 30, 1946.
18. Mason, M. L.: Aseptic and antiseptic measures as they affect the incidence of infections in surgery, *Inter. Abs. Surg.*, 69:112-114, Aug. 1939.
19. Mason, M. L.: The immediate treatment of open wounds of the hand, *The Miss. Valley Med. Jour.*, 61:136-143, July 1939.
20. Mason, M. L.: Infections of the hand, symposium on surgical infections, *Surg. Clinics No. Amer.*, 22:455-477, April 1942.
21. Mason, M. L.: Principles of management of infections of the hand, Reprint from the *Rocky Mountain Med. Jour.*, Nov. 1940.
22. Mason, M. L.: Pitfalls in the management of hand infections, Reprint from *Minn. Med.*, 20:485, Aug. 1937.
23. Mason, M. L.: The treatment of open wounds of the hand, *Surg. Clin. No. Amer.*, 28:4-28, Feb. 1948.
24. Meleney, F. L.: Penicillin in treatment of surgical infections, *Ann. Surg.*, 124:962-971, Nov. 1946.
25. Meleney, F. L.: Treatment of surgical infections with antibiotics, *Bull. U. S. Army Med. Dept.*, 8:445-451, June 1948.
26. Meleney, F. L.: The topical use of antibiotics in established surgical infections, *Surg. Gyn. Obst.*, 86:760-762, June 1948.
27. Requarth, W. H.: Diagnosis and treatment of localized infections, *U. S. Nav. Med. Bull.*, 46:1354-1367, Sept. 1946.
28. Requarth, W. H.: Infections of the hand, *Surg. Clin. No. Amer.*, 28:27-45, Feb. 1948.
29. Siler, V. E.: Management of acute infections, *Ohio State Med. Jour.*, 38:922-924, Oct. 1942.